STAT 5412
Biostats 1: Linear Models

Instructor: Alejandro Chavez Treviño

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RAS 126
10:00 AM - 11:50 AM, M,W,F
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Office Hours: Fridays, 1:00 PM to 2:00 PM, or by appointment.

1 Course Overview

This class introduces the basic concepts, mathematics, and applications of modern statistical methods. We will begin with simple foundations of measurement theory, and steadily build towards framing ecological hypotheses as statistical models. Then we will learn to assess the performance of those models and explore the limitations of simplistic assumptions. We will also touch on the foibles of statistics past, contextualize the long history of statistical impropriety in ecology, and work towards a general statistical literacy throughout the course. By the end of this course you will be able to:

1. Summarize the expected value and uncertainty in your data.
2. Pose a hypothesis in terms of a statistical model.
3. Fit linear models to real data.
4. Interpret the estimated parameters of your models.
5. Assess the performance of fitted models.

2 Required Texts

Fieberg, J. 2022. Statistics for Ecologists. An open-source online textbook.
https://fw8051statistics4ecologists.netlify.app/

3 General Assignments

I will assign exercises each week to reinforce the material. All work in this class will be done in R, which is a free statistical analysis package (and so much more, as you will see). It is best that you install both R and R Studio, which is a convenient interface. They are available for free download at:

- **R:** https://cloud.r-project.org/
- **R Studio:** https://rstudio.com/products/rstudio/download/

All assignments integrate written work and statistical results, so we will utilize a typesetting program called LaTeX within R Studio to do all assignments. The easiest and most reliable way to get started with LaTeXin R Studio is called TinyTex, which can be installed following the procedures shown here: https://www.youtube.com/watch?vōF_KI4SLuBs&ab_channelĀmeliaMcNamara

4 Grading Policy

Grades are based on weekly assignments, and 2 exams (midterm and final). Each of these categories contribute contribute 50% of your final grade.

Letter grades follow: $100 > A \geq 90 > B \geq 80 > C \geq 70 > D \geq 60 > F$. There is no curve.
Late work will be eligible for up to 90% credit if 1 day late, 50% credit if 2 days late, and will not be graded if 3 or more days late, resulting in a 0. This policy will be strictly enforced.

5 Attendance

Showing up is the only way to get the material you need. If you don't come to class, your grade will reflect it with no penalty needed from me. In the event of an excused absence, make arrangements with me to go over material ahead of time.

6 Academic Dishonesty

Academic dishonesty includes copying, sharing, or obtaining information from an unauthorized source, attempting to take credit for the intellectual work of another person, falsifying information, and giving or receiving information about a test, quiz, or assignment to other students. Any student involved in academic dishonesty will receive no credit (0) for work done and/or may be penalized in accordance with published University Rules.

7 Counseling and Accessibility Services

Sul Ross State University is committed to equal access in compliance with the Americans with Disabilities Act of 1973. It is the student's responsibility to initiate a request for accessibility services. Students seeking accessibility services must contact Mary Schwartze, M. Ed., L.P.C., in Counseling and Accessibility Services, Ferguson Hall, Room 112. The mailing address is P.O. Box C-122, Sul Ross State University, Alpine, Texas 79832. Telephone: 432-837-8691. E-mail: mschwartze@sulross.edu.

8 Course Schedule (Tentative)

- Module 1: Basic Concepts
  - **Week 1 (8/26-8/30):** Course Intro and Fundamentals
    - Lecture 1: What is statistics anyway?
    - Lecture 2: What are (parametric) statistics?
    - Lecture 3: A brief introduction to R
    - Exercise: A pRimer
  - **Week 2 (9/2-9/6):** The very basics
    - Lecture 1: Off for Labor Day
    - Lecture 2: Scales of measurement, Central tendency, and variability: what do we expect?
    - Lecture 3: Frequency to probability, discrete and continuous events
    - Exercise: Continua, Categories, and Interpreting Probabilities
  - **Week 3 (9/9-9/13):** Uncertainty and the Reduction Thereof
    - Lecture 1: Understanding the normal distribution
    - Lecture 2: Conditioning the normal distribution
    - Lecture 3: Conditioning the normal distribution con't.
    - Exercise: What is Normal?
  - **Week 4 (9/15-9/20):** The problem of sampling
    - Lecture 1: Limited information and levels of uncertainty
    - Lecture 2: Distributions... distributions everywhere!
    - Lecture 3: Sampling and simulation
    - Exercise: Understanding sampling by simulation
  - **Week 5 (9/23-9/27):** What if variable things are related?
    - Lecture 1: Joint distributions and their interpretation
    - Lecture 2: Handy parameters of a BVN, Least-Squares shortcuts, and non-parametric analogs
    - Lecture 3: Confidence intervals of correlation
    - Exercise: Relationships and such
  - **Week 6 (9/30-10/4):** Midterm week
    - Lecture 1: Review day
    - Lecture 2: Review day
    - Lecture 3: Exam Day!!!

- Module 2: Getting to the good stuff: Simple Linear Models
  - **Week 7 (10/7-10/11):** Cause, effect, and covariates.
    - Lecture 1: The basic linear model
    - Lecture 2: Conditional parameters as hypotheses
    - Lecture 3: Discrete and continuous covariates
    - Exercise: Conceptualizing your hypothesis/model
  - **Week 8 (10/14-10/18):** Is my little model any good?
    - Lecture 1: Diagnostics, test statistics, and p-values
    - Lecture 2: Simple models mean simplistic assumptions
    - Lecture 3: Outliers and other anomalies
    - **Reading: ASA Statement on p-values**
    - Exercise: Test statistics
  - **Week 9 (10/21-10/25):** Multiple Regression
    - Lecture 1: Interpreting models with multiple covariates
    - Lecture 2: Fitting and assessing such models
    - Lecture 3: Additional assumptions
    - Exercise: Multiple predictors
  - **Week 10 (10/28-11/1):** A little more complexity
    - Lecture 1: Introduction to interaction terms
    - Lecture 2: Interpreting interaction terms 1
    - Lecture 3: Interpreting interaction terms 2
    - Exercise: Interacting predictors

- **Week 11 (11/4-11/8)**: Choosing models: more on complexity
  - Lecture 1: How not to cut yourself with Occam's Razor
  - Lecture 2: Information theory and parsimony
  - Lecture 3: Practical model selection
  - Exercise: Model Selection

- **Week 12 (11/11-11/15)**:Sampling designs and linear models
  - **Reading:**
  - Lecture 1: Randomized Block Design
  - Lecture 2: Structured Sampling
  - Lecture 3: Correlative Studies
  - Exercise: Simulating an experiment

- **Week 13 (11/18-11/22):** Contextualizing the Past
  - **Reading:**
  - Lecture 1: Significance Testing: A problematic fairy tale
  - Lecture 2: Thanksgiving Break
  - Lecture 3: Thanksgiving Break

– **Week 14 (11/25-11/29):** Data Transformation Do's and Don'ts
  * **Reading:**
  * Lecture 1: Transforming to "achieve" normality
  * Lecture 2: Log-normal models for population growth
  * Lecture 3: Transforming covariates
  * Exercise:

– **Week 15 (12/2-12/6):** Introducing the General Linear Model!
  * Lecture 1: What you've done: The gLM
  * Lecture 2: What's to come: the GLM
  * Lecture 3: None - Finals Begin

– **Week 16 (12/09-12/13):** Final Exam Week
  * Final Exam (per SRSU schedule)